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The ILLUMINATING ENGINEER

ELECTRICITY · ACETYLENE · OIL · GAS

Edited by LEON GASTER

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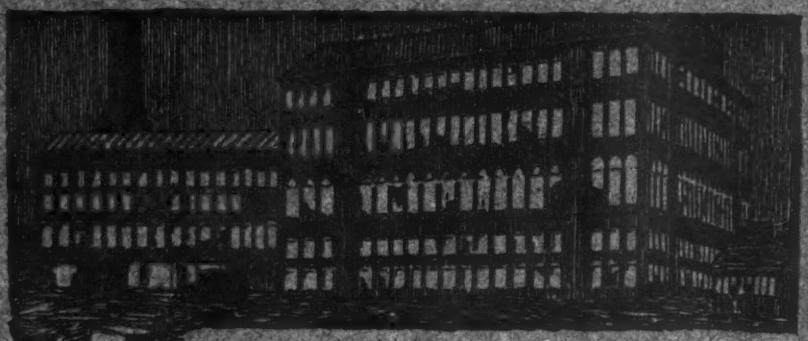
This number contains an account of the proceedings at the **Conference,** arranged by **The Illuminating Engineering Society** at the British Empire Exhibition on August 12th, 1924, when papers on the following subjects were read :—

The Best Means of promoting Public Appreciation of the Benefits of Good Lighting, by L. GASTER.

Illumination of Highways from the Motorists' Point of View, by EDWARD H. FRYER.

Some Notes on the Lighting of the British Empire Exhibition, by (1) HAYDN T. HARRISON **(Electric)** and (2) G. L. JENNINGS **(Gas).**



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EDITORIAL.

The Conference on Illuminating Engineering at Wembley.

The Conference on Illuminating Engineering, which took place at the British Empire Exhibition on August 12th, was timely for several distinct reasons. In the first place it furnished an opportunity for reporting on the proceedings at the Conference on Industrial Hygiene and the meeting of the International Illumination Commission, held in Geneva during July; and also surveying discussions at the World Power Conference held at Wembley in the same month. Secondly, it enabled several subjects of great topical interest—such as the question of street lighting from the motorists' standpoint, dealt with by Mr. E. H. Fryer, and the two papers on the Exhibition Lighting by Mr. Haydn T. Harrison and Mr. G. L. Jennings. Thirdly, it was desirable, as marking a new stage in the development of the illuminating engineering movement in this country, and reviewing its extension in the future.

As regards the proceedings at Geneva the dominant point in the deliberations of the Congress on Industrial Hygiene was the recognition of the importance of good lighting as an essential element in health, safety and efficiency. Expression was given to this view by a special resolution, and the papers read by Prof. Oblath, Dr. Stassen and the writer strongly

emphasised the drawbacks of bad lighting, both in relation to general health and vision, in mines and factories. It is hoped that one result of this Conference will be closer relations between hygienists and lighting experts in different parts of the world. It is only within recent years that due attention has been given to this particular aspect of illumination—its direct relation with *health and hygiene*.

At the International Illumination Commission a variety of papers on scientific subjects were read. A new feature—with which we are mainly concerned for the moment—was the inclusion of several papers by Messrs. Lieb, Merril and Powell dealing with steps taken in the United States to promote public appreciation of the benefits of good lighting. With this problem the whole future of the illuminating engineering movement in this country is intimately associated. During the last 16 years we have been occupied mainly in gathering information and in a career of self-education. The main principles of good lighting are now clearly defined. We have established machinery by which details can be studied, and intercourse both with other bodies and with leading experts of other nations assured. The next step is concentration on the task of making this information known to the general public, to make them participators in an extensive movement for better lighting, and to put into practice the results of the pioneering work of the Illuminating Engineering Society, carried out during the past 16 years.

All this involves educational propaganda on an extensive scale. How and by whom is this propaganda to be carried out ? Much can be done by individual members of the Society, by firms in the lighting industry, and by gas and electric supply undertakings. But experience in the United States, which has fully endorsed the necessity of the Illuminating Engineering Society as an impartial central force linking together all these activities, will be repeated here. It is therefore essential, if the full results of past work are to be obtained, that the Society, in co-operation with other bodies, should receive full support for the scheme outlined at the Conference. A Resolution (see p. 122) was passed unanimously approving such a scheme, and commending it to the support of institutions for the encouragement of research, all sections of the lighting industry, and the general public. Some of the objects in view have been indicated. They include the reorganisation of THE ILLUMINATING ENGINEER so as to include more popular matter and appeal to a wider section of the public ; the organisation of courses in illuminating engineering at colleges, frequent public lectures, and articles in the daily and technical Press emphasising the benefits of good illumination, etc.

Finally, there remains one very important aspect of the movement—its relation to developments in other countries. From the very first it has been our aim to establish relations with experts and sources of information on lighting in all parts of the world. The Society is in touch with similar bodies abroad. The journal can count on the assistance of correspondents in all the chief cities of Europe and the United States. The proceedings at Geneva showed how valuable this international intercourse has become, and it must be our aim in the future to see that this country maintains its position as the centre of the illuminating engineering developments in Europe.

The Problem of Public Lighting.

The question of public lighting, which is now receiving much attention, was discussed in some detail at the Annual Meeting of the Institution of Public Lighting Engineers, held in Glasgow during September 16th-18th. Mr. Langlands, in his presidential address, traced the development of the Glasgow Corporation Lighting Department, and gave an account of the work done in its offices and laboratories. We could wish that all cities were equally well served in this respect.

It is now generally agreed that the great growth in the volume of fast-driven motor-traffic renders necessary much better public lighting than was tolerable in the past. In most business thoroughfares the problem is dominated mainly by the requirements of traffic. This has led to the idea that efficient lighting of streets involves concentration of the greater part of the flux of light on the roadway by the aid of " projector " sources, which are virtually stationary headlights.

It must, however, be recognised that the convenience of motor-traffic, though an exceedingly important consideration, is not the *only one* that determines the choice of public lighting. In first class thoroughfares a system of lighting which allotted light only to the roadway, leaving the faces of buildings in darkness, would not be acceptable. Something is due to the pleasing appearance of the street. This was well expressed in the paper read by Mr. Stewart at Glasgow. A lighting expert has to consider how a method of public lighting will impress his council, and they in turn are anxious to adopt a system which the " man in the street " will approve. A system of lighting of an exceptional and peculiar kind, even if admirably adapted to the needs of the motorist, might not be acceptable in the streets of a large city.

The case of the important arterial routes between cities, now under consideration, stands on a different footing. Here the main consideration is, undoubtedly, the convenience and safety of traffic. Moreover, the expense of lighting such a long length of roadway is very considerable, and must be reduced to a minimum by ensuring that all the available light is most efficiently used. Hence, for routes of this kind, it seems possible that the use of stationary headlights at the sides of the road, directing their beams well below eye-level and flooding the roadway with light, may prove a feasible method.

In regard to the general lighting of cities one point is becoming increasingly clear. The best solution of the " dazzling headlight problem " lies in providing adequate street lighting. In a well-lighted street headlights become unnecessary and the motorist is relieved from furnishing his own street-lighting, inevitably at some inconvenience to others. Local authorities are human—if they grudge the cost of proper lighting it is because they doubt whether ratepayers will acquiesce in the expense. If the public can be educated to take a pride in the lighting of their city, to demand good illumination, under the control of a properly qualified public lighting engineer, we shall soon see a great improvement in present conditions.

Modern Photometry—its Extending Applications.

When one looks back at the conditions prevailing before the year 1908, when the illuminating engineering movement in this country may be said to have been initiated, one cannot but be struck by the changed status of photometry. Once regarded merely as an interesting laboratory process—a subject for discussion by professors and physicists—it has now become the basis of treatment of practical lighting problems. It has enabled us to appreciate the difference in distribution of light by various illuminants, and aided us in designing globes, shades and reflectors. Without illumination-photometers we should have been unable to detect with any precision the great variations in illumination found in practice for one and the same process, or to conduct those tests on which our ideas of modern requirements are based. Illumination photometers have furnished a means by which the actual results of lighting specifications may be checked and the benefits of improved systems of lighting demonstrated.

Photometry, however, has come to our aid in many unexpected directions. The Joint Committee of the Illuminating Engineering Society dealt during the war with the illuminating power of flares used in trench warfare (attaining thousands of candles) and the brightness of self-luminous radioactive materials used for gunsights comparable with average moonlight—an apt instance of the enormous range with which we can deal.

A paper recently read by Mr. W. F. Little before the American Illuminating Engineering Society reviews some of the latest developments. We see illustrated methods of testing glassware in the laboratory ; tests of street lamps in position by means of a motor-lorry which is substantially a travelling photometer-room ; and the use of small models to enable the lighting requirements of buildings to be specified. Next there is the study of shadow—for instance, the diminution in illumination caused by the shadow of a person seated at a desk. With a highly diffused system of lighting, and very soft shadows, this diminution might be entirely unsuspected by the unaided eye ; but, nevertheless, a photometric measurement may show that it is there. Yet another interesting case of diminished illumination revealed by the photometer occurred after the introduction of masses of dark coloured machinery in a workroom with white walls. The illumination in practice proved much less than that anticipated from tests in the empty room—simply because of the blockage by the machinery of much of the reflected light.

Finally, there are the complex problems involved in colour-photometry, formerly regarded as wholly mysterious, but now met with fair precision, and especially the judgment of the effect of " artificial daylight," which is receiving so much attention at the present time. Even these instances by no means exhaust the modern applications of photometry, which form the basis of scientific illumination. In the case of a rapidly developing subject, such as photometry, a knowledge of the results obtained by different workers, both in this country and abroad, is of the greatest importance, and the Illuminating Engineering Society is fulfilling an important function in co-ordinating data of this description.

L. GASTER.

TRANSACTIONS

OF

The Illuminating Engineering Society.

(Founded in London, 1909.)

The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.

THE CONFERENCE ON ILLUMINATING ENGINEERING.

(Held in the Palace of Industry, British Empire Exhibition, at 2.30 p.m. on Tuesday, August 12th.)

A SPECIAL conference, under the auspices of the Illuminating Engineering Society, was organised at the British Empire Exhibition on Tuesday, August 12th, when there was a very representative audience, including both engineers connected with firms manufacturing lamps and lighting appliances and gas and electric supply undertakings, and members of the general public and users of light.

During the initial stage of the proceedings the chair was taken by Mr. J. W. BEAUCHAMP (Director of the British Electrical Development Association).

The CHAIRMAN (Mr. J. W. Beauchamp), in opening the proceedings referred to the valuable work on illuminating engineering which had been done by Mr. Gaster since the movement started. The great difference between the best and mediocre lighting conditions was not sufficiently appreciated by electric supply undertakings, and there was a great need for propaganda in favour of better lighting at the present time. Mr. Gaster, in his address, would deal with proceedings at the recent congresses in Geneva, and the recommendations made on that occasion, which were of the utmost value. Mr. Gaster had emphasised the view that proper lighting should be regarded as an essential element in hygiene, and he (Mr. Beauchamp) entirely subscribed to this view.

Mr. LEON GASTER, in the course of a few remarks introductory to his address, recalled that it was seventeen years since the idea of studying illumination and its applications was first originated in this country. At that time some suggestion had been made that the Society would soon exhaust its subject. Experience had shown, however, that each discussion revealed new problems, and the Society at the present time could see sufficient work ahead to occupy it for many years. The chief object of the present Conference was to inform the public of the benefits of good lighting. Illumination should be regarded primarily from the standpoint of health. From early youth to old age artificial light was required and the hygienist and lighting expert should join hands in determining *firstly* in what good lighting consisted, and *secondly* how the desired conditions could best be obtained.

Mr. Gaster then proceeded to deliver his address on "The Best Means of Promoting Public Appreciation of the Benefits of Good Lighting" (see pp.

123-124), in the course of which he gave an account of the papers presented and resolutions passed at the First International Conference for the study of Industrial Hygiene, and the meeting of the International Illumination Commission, held in Geneva during July.

In the ensuing discussion Mr. W. H. RAWLINGS, Mr. MURRAY GRIFFITH, Mr. C. RAPHAEL, Miss R. E. SQUIRE (Home Office Factory Dept.), Mr. J. ECK, Mr. W. T. DUNN (Institution of Gas Engineers), Mr. W. E. BUSH, and Mr. L. E. BUCKELL took part.

After Mr. GASTER had briefly replied to some of the points raised, the CHAIRMAN put to the meeting the following Resolution :—

(1) That, as a result of eighteen years of experience of Illuminating Engineering in this country and in the United States, this Conference considers that the time is ripe for a comprehensive effort to promote public appreciation of the benefits of good lighting, and views with approval the desire of the Illuminating Engineering Society to prepare a suitable scheme for this purpose, with the co-operation of other bodies interested in various aspects of illumination.

(2) This Conference recommends that every support should be given by institutions for the encouragement of research, members of the public and by all sections of the lighting industry to the Illuminating Engineering Society in carrying out such a scheme.

Captain W. J. LIBERTY (Public Lighting Inspector to the City of London), in seconding the Resolution, urged that those associated with all aspects of illumination should co-operate with the Society in the aims it had in view. Mr. GEO. HERBERT, who also supported the motion, pointed out that the desired co-operation could best be secured by an impartial body, such as the Illuminating Engineering Society, in which makers of lamps and lighting appliances, gas and electric supply undertakings and members of the public concerned with the use of light, were all represented.

The Resolution having been declared carried unanimously, the Chair was taken by Captain W. J. LIBERTY, who called upon Mr. EDWARD H. FRYER (Head of the Road Department of the Automobile Association) to read his paper on "Illumination of Highways from the Motorist's Point of View" (see pp. 128-130). Mr. Fryer dealt in succession with the nature of lights that should be carried by motor-vehicles, the desirable public lighting from the motorist's standpoint, and the use of warning lights to indicate dangerous places, temporary and permanent obstructions, etc. He pointed out that existing procedure in regard to warning lights is apt to cause confusion and made suggestions for removing this drawback.

In the ensuing discussion Mr. W. T. DUNN, Mr. E. D. ALLEN, Mr. F. POTTERTON, Mr. W. R. RAWLINGS, Mr. MURRAY GRIFFITH, Mr. PICKERING, Mr. J. S. DOW, Miss A. WIGGINS and the Chairman took part.

Mr. LEON GASTER then occupied the Chair for the final stage of the Conference, in the course of which the papers by Mr. G. L. JENNINGS (see pp. 132-133) and Mr. HAYDN T. HARRISON (see pp. 131-133) dealing respectively with the gas and electrical sections of the lighting of the British Empire Exhibition, were read. Owing to Mr. Harrison's unavoidable absence through indisposition his paper was presented by Mr. C. H. CUNLIFFE.

In the ensuing discussion the CHAIRMAN, Mr. C. E. RAPHAEL, Mr. F. C. TILLEY, Mr. GEO. HERBERT, and Mr. J. S. DOW took part. Attention was drawn to the exceptionally high illumination prevailing in the gas lighted section, and to the novel methods of concealed light employed for the electric lighting. In regard to the latter, however, it was explained that it had been found impossible to carry out the original scheme in its entirety, with the result that in certain sections of the exhibition supplementary methods of lighting had to be installed.

The proceedings were terminated by a cordial vote of thanks to the lecturers and to the Chairmen.

THE BEST MEANS OF PROMOTING PUBLIC APPRECIATION OF THE BENEFITS OF GOOD LIGHTING.

(Some Notes on the Proceedings at the First International Conference on Industrial Hygiene and the Meeting of the International Illumination Commission held in Geneva, July, 1924.)

By L. GASTER, F.J.I.

(Abstract of a paper read at the Conference on Illuminating Engineering, held at the British Empire Exhibition (Hall No. 3, Palace of Industry), on Tuesday, August 12th, 1924, 2.30—5.30 p.m.)

THE International Conference on Industrial Hygiene, held under the auspices of the University of Geneva during July 18th to 20th, was the first gathering of the kind held since the war. The Swiss organising committee was under the Presidency of Professor Dr. Cristiani, Director of the Institute of Hygiene, and the arrangement of the Conference was also due largely to the efforts of Dr. L. Carozzi, a valued corresponding member of the Illuminating Engineering Society. The Conference dealt with various hygienic aspects of illumination. A paper on industrial lighting was read by the author, and the communications by Professor O. Oblath on Ocular Fatigue, and by Dr. Stassen on Miners' Nystagmus also contained frequent reference to the prejudicial effects of inadequate lighting on vision. The Conference cordially approved the view that good lighting, in common with proper ventilation, heating and sanitation, should be regarded as essential to the health of workers. The Conference provided a favourable opportunity of bringing the subject of illumination before the notice of physiologists and experts on hygiene. The author emphasised the need for consultation between such experts and those familiar with the technicalities of illumination, and a resolution affirming the desirability of such co-operation was passed. It was agreed that such consultation should be made a feature of future congresses, and that the International Illumination Commission should keep in touch with the Hygiene Section of the International Labour Bureau of the League of Nations in order that specific problems in regard to industrial lighting, etc., might be brought before the notice of the Governments of the respective countries.

At the meeting of the International Illumination Commission, likewise held in Geneva, immediately following the above Conference, a great variety of papers, dealing with such subjects as symbols and nomenclature, photometry, colour-effects, visibility, etc., were read. The writer again contributed a paper dealing with industrial lighting, and a report on this subject was presented by the technical sub-committee of which he was a member. There was a general recognition that regulations for industrial lighting should be based primarily on obtaining conditions essential to the health and safety of workers, and that at present standard minima for working illumination should not be enforced by law. At the same time *recommendations* in the interests of efficient production would be welcome, and this aspect should be studied with the aid of representatives of the industries concerned. In addition to the report of the sub-committee two detailed codes, illustrating the latest practice in the lighting of schools and factories, were presented by the American Illuminating Engineering Society. The former was issued jointly by the Illuminating Engineering Society and the American Institute of Architects, and in both cases the revision of the code was effected with the aid of many other kindred bodies and associations interested in various aspects of the subject.

From the standpoint of this Conference special interest attaches to three papers dealing with the problem of Promoting Public Appreciation of the Benefits of

Good Lighting, namely, "The Furtherance of Good Lighting by American Central Stations," by Dr. John W. Lieb; "Demonstration Methods of Teaching Good Lighting Practice," by G. S. Merril; and "Practical Illuminating Engineering," by A. L. Powell. Dr. Lieb pointed out the great value to central stations of encouraging the tendency to adopt better lighting and to utilise for longer hours installations which are pleasing and give improved economic results. After quoting data on the demand for lamps of different wattages and the number of lamps installed in typical residences, he estimated that at present lighting forms barely 1 per cent. of the cost of living of the average family, and he summarised some of the chief advantages to be obtained by better lighting. Methods of co-operation between electric lamp manufacturers and electricity supply companies were described and an account given of the "National Movement for Better Home Lighting" which organised essay-competitions for children on the lighting of the home, and other forms of propaganda. The part played by the Illuminating Engineering Society in correlating all these activities was emphasised.

Similar instances of co-operation on a large scale were given in Mr. Merril's paper, and the method of conducting demonstrations was described in detail. Mr. Powell also described various forms of propaganda and gave a brief survey of a large number of investigations, some statistical and others dealing with specific effects of illumination. Attention was drawn to the arrangement being adopted in the United States whereby the National Research Council is to institute unbiased and authoritative investigations of results to be obtained by better lighting.

The conclusion to be drawn from these papers is the necessity for joint effort on the part of all sections of the lighting industry in this country, as in the United States, and the desirability of enlisting the help of independent bodies in order to ensure rapid progress of the movement for the promotion of better lighting. The Illuminating Engineering Society has already done valuable work, but with adequate support from the lighting industry could do a great deal more to expedite progress on a large scale. Amongst the steps that suggest themselves for this purpose are: (1) the arrangement of frequent public lectures and papers before industrial and other organisations, emphasising the results to be obtained by better lighting; (2) the initiation of lectures in colleges and simple addresses in the schools, the organisation of essay-competitions on illumination, etc.; (3) the publication of unbiased articles on lighting in the daily and technical Press; (4) the organisation of demonstrations of lighting, which should be conducted not only by manufacturers but by gas and electricity supply undertakings throughout the country; (5) the fuller recognition on the part of supply companies that their functions include "service" as well as the supply of gas and electricity, and the organisation of illuminating engineering departments by the various gas and electricity supply undertakings; (6) the furnishing of adequate support to the Illuminating Engineering Society in order to enable it to correlate these various activities, and to its official organ which forms an essential adjunct in propaganda work.

DISCUSSION.

Mr. W. R. RAWLINGS (Past President of the Electrical Contractors' Association), in opening the discussion, thanked Mr. Gaster for the information he had put before the Conference. He was well aware of the good work that was being done by the Chairman and the British Electrical Development Association in bringing the advantages of good lighting before the public, but he felt that there was still need for more co-operation between supply-undertakings and makers of lamps and fittings. Once people were led to appreciate the benefits of good lighting they never desired to return to the old conditions. Formerly people had to get along with very little light. Now that artificial light was more abundant there was some danger of their going to the other extreme. It was

necessary to see that this light was wisely used and properly distributed. The time had come when it should be very carefully considered how far the light-energy emitted by the source was being usefully employed, and to what extent it was being wasted.

Mr. MURRAY GRIFFITH agreed that propaganda which would educate people in the proper use of light was badly needed. Anyone who was fortunate enough to have his house lighted in a scientific manner was at once aware of the difference, as compared with unsafe, unsatisfactory methods. It was common experience in a house where the lamps were incorrectly placed that one was always finding oneself "in one's own light." Good lighting in the kitchen was of great importance. The brightness of the modern lamp was such that screening was essential, and if stairs were lighted without proper attention to shading one was apt to lose sight of the last stair.

Mr. C. RAPHAEL (Consulting Engineer) said that the Illuminating Engineering Society had done, and was doing, most excellent work—largely due to the efforts of Mr. Gaster. But in order to get right down to the public it was necessary to enlist the help of other organisations. One official who could do a great deal to induce the owner of a works to appreciate the importance of good lighting was the factory inspector. Perhaps in his reply Mr. Gaster would be able to tell the Conference a little more regarding the Home Office recommendations on lighting. He understood that it was intended to include clauses on lighting in the next Factory Act.

Another person whose co-operation in lighting matters should be sought was the architect. Then there was the consulting engineer. Unfortunately few people could afford to employ both a consulting engineer and an architect, and the former's services were usually sought only in the case of big buildings. Consequently the lighting was frequently left in the hands of the architect and it depended very much on the interest which he took in this subject whether the conditions of illumination were satisfactory or the reverse. One of the most important men of all was the electrical contractor. It was absolutely essential that he should be familiar with the principles of good illumination.

As regards intensity of illumination it would appear that technical publications in general gave the minimum figures. It was impossible, or practically so, within the bounds of economy to produce the equivalent of daylight illumination by artificial means; one must in practice be content with a lower value. Hence if evenly diffused illumination was produced the average intensity was much less than that of daylight. It appeared, however, that the best working conditions were to be secured with an illumination considerably higher than the minimum, and this value should be provided, not necessarily in all parts of a room, but at the place where work was done. Thus, even under present conditions, one was brought back to a method characteristic of the days when there was only one lamp in the middle of the room and the whole family sat round it—with the difference that for the other part of the room the illumination should not be below the prescribed minimum.

It was, however, essential that the contrast between the illumination at the place where work was done and the general illumination should not be too great. If the eye had to adjust itself every time a man looked away from his work and back again, eyestrain was liable to result. A new standard, a ratio between the working and the general illumination was needed; it must not be too great for the reasons indicated, while if it approached unity one obtained an uneconomical and unduly monotonous effect.

Miss R. E. SQUIRE (Home Office, Factory Dept.), said that there was at the moment before Parliament a Factories Bill to amend and consolidate the Factory Acts. A clause in that Bill contained the requirement that every factory should be provided with suitable and adequate means of lighting in every part. Having laid down that principle the Bill gave the Secretary of State power to make an Order prescribing what was suitable and adequate under the different circumstances of factory life. In this matter legislation was by no means in advance of inquiry, which had been

proceeding for a number of years. The first report of the Departmental Committee on Lighting in Factories and Workshops was published during the War. There was then an unavoidable interval before sittings were resumed. The Committee had recommended to the Factory Department the step indicated above, and also had advised the Secretary of State as to what was suitable and adequate. Suitability included the important matters of absence of glare, contrast, flicker, etc.

On the difficult question of what was adequate for factory processes there had been still further investigations.

When the Committee reported to the Home Secretary it had to report that on the evidence before it it was not able to recommend that a minimum illumination for certain processes should be laid down. What it did after careful investigation of different processes in factories was to publish what it considered to be good practice. Employers and workers in the trade concerned had been asked to criticise the schedules of processes and the degree of illumination attached to those processes. Inquiries had been made of a very large number of trades. It was, she thought, satisfactory to know that, on the whole, there had been agreement with what had been proposed.

The experience of those at the Home Office was that there was a very great need for more propaganda. Readings had been taken in factories and the difference in the amount of illumination for the same processes in the same factory was astonishing. Very often the employer was most anxious to know what he should do. He had perhaps put himself in the hands of someone who had simply asked him what he wanted, and who had put in a certain installation which met neither his needs nor his taste. It was necessary to educate the workers also. They were asking for demonstrations. Then there were others in whose hands actual practice in the factory largely rested, namely, the foreman, and forewoman and the works managers. If the Illuminating Engineering Society could put forward such propaganda as would help all those various interests it would be very much welcomed and would assist very much in the second reading of the Factories Bill and, if that should become law, in the making of Orders by the Secretary of State to meet the needs of the trades.

Mr. J. ECK felt that the general public suffered very greatly from bad illumination. Children were brought into badly illuminated schools, universities, museums, etc.; yet when one went to those responsible for the illumination of those places it was often difficult to get a hearing. It was most important that those interested in the subject should go to the general public with propaganda showing what good illumination was and what it could do. The Society had had a very difficult battle to fight during the last seventeen years, ten of which had been occupied by the war and the period after the war. Now the world was very poor and had to look at everything from the pounds, shillings, and pence point of view. There was a limit to what each member individually could do and it was therefore necessary that the membership should be considerably increased. He asked those present who were interested in lighting to join the Society.

It was proposed that the Journal of the Society should be made a little less scientific and a little more popular and that it should get closer to the public that used illumination. He was very glad that there was a good attendance at the Conference. The giving of lectures was a very good thing and he would gladly give a lecture on the subject of illumination whenever he had the time to spare.

He would ask that, preparatory to the organisation of lectures all those present at the Conference and all those who were at the Conference in thought should do their best to interest their neighbours and their friends who used light in one way or another. All his life he had been connected with the electrical industry, lighting and power; but he had a great appreciation of what had been done by the gas industry. The difficulties which that industry experienced were much the same as those experienced in the electrical industry. People did not understand that in order to have proper illumination

and a healthy atmosphere it was necessary to have properly graded, properly placed and properly shaded lights.

Mr. W T. DUNN (Institution of Gas Engineers) bore testimony to the value of the work that is being done by the Illuminating Engineering Society. The Institution of Gas Engineers had watched the progress ot the Society very carefully and very sympathetically. What he appreciated more than anything else was the fact that the Society did not take up any particular form of illuminant and champion that. All it dealt with was illumination, whether it was derived from the sun, gas, electricity, acetylene, or any other source.

Mr. W. E. BUSH (E.L.M.A.) congratulated Mr. Gaster on the clear and precise manner in which he made his statement. He did not know that the time was yet ripe to endeavour to establish international codes ot illumination. One code might not suit all the different countries of the world. The situation varied so much. Possibly, however, factory lighting and one or two other problems might be exceptions. There was no question that in the electrical industry there was a need for greater co-operation than existed at the present time. It was necessary to get all those at the Central Station, and, in fact, all branches of the electrical industry to realise that the subject of light was of vital importance to them. If the present Conference had had the effect of bringing all the different branches into closer co-operation, it would have served a very usetul purpose.

Another speaker remarked that the supply authorities with which he had been privileged to associate for the last thirty years had one and all had the business rolling in, and they said, "Why should we do anything?" They did not employ a staff which knew anything about the matter to educate the public. Betore propaganda work on a sound basis could be started it would be necessary to have a large number of competent teachers available.

Mr. L. E. BUCKELL said that the Illuminating Engineering Society was almost the only one which studied the question of illumination. The question of co-operation was the crux of the whole matter. There was no body in this country which by itself was big enough to handle the enormous subject of illumination. The first thing to be done was to get together all the various organisations, representing manufacturers, central stations, contractors, the scientific bodies and the different types of users. The next thing to be dealt with would, surely, be the question of education. There must be available a well-equipped and well-trained body of men who were actually in touch with the users of light.

Mr. W. T. DUNN referred to the work of the International Illumination Commission in bringing about agreement on lighting problems throughout the world. He urged the great importance of standardisation.

Mr. L. GASTER, in the course of a brief reply, thanked Miss Squire for her contribution to the discussion which he thought covered the inquiry made by Mr. Raphael. He was very glad that there was a good prospect of adequate and suitable factory lighting becoming part of the law of the land. Miss Squire had explained the steps taken by the Home Office Factory Department to consult various leading industries regarding the conditions of illumination desirable in each case. He himself had always been opposed to legal minima for working illumination, feeling that these were not justified by present knowledge, and might act to the detriment ot advances in illumination, instead of accelerating them.

Allusion had been made to the work of the Society, which had been carried out under very difficult conditions, especially during the war period. It was now felt, after the Society had established its impartiality and had acquired so much useful information, that it should be given the opportunity to press onward with its programme on a suitable scale.

The Resolution approving the scheme for propaganda and education, the text of which appears on p. 122, was then put to the meeting and passed unanimously, after which the Chair was occupied by Capt. W. J. Liberty. Mr. Edward H. Fryer then read his paper entitled "Illumination of Highways from the Motorist's Point of View."

ILLUMINATION OF HIGHWAYS FROM THE MOTORIST'S POINT OF VIEW.

By EDWARD H. FRYER (Head of the Road Dept., Automobile Association).

(Abstract of a paper read at the Conference on Illuminating Engineering, held at the British Empire Exhibition, Wembley, on Tuesday, August 12th, 1924, 2.30—5.30 p.m.)

ON broad lines the motorist of to-day requires something far in advance of the old-fashioned form of street lighting which was considered sufficient in other days.

Motorists' requirements fall into three groups, *i.e.*,

(1) Illumination provided on his, or her, own car or motor cycle ;

(2) Extraneous lighting—provided by street lamps or buildings adjacent to roads and streets ; and

(3) Warning lights—to indicate dangerous places, temporary and permanent obstructions.

In each group motorists are confronted with natural difficulties, chiefly climatic, in regard to rain, snow, fog and wind, while the provision of more light could possibly endanger other road users.

In the author's experience the most satisfactory form of lighting (electric) for a motor car might be summarised as :—

Two headlights, the near side one focused straight ahead and the off side one focused slightly towards the near side.

An auxiliary light under the near side dumb iron fixed as low as possible and focused on to the edge of the road (when driving a yard or so from the edge) at a distance 8 to 10 yards ahead of the car. These three lights should be controlled by a couple of switches handy to the right thumb.

Two side lights, the near side one focused with a horizontal beam and the off side one depressed so as to avoid dazzling meeting traffic.

One tail light on the off side.

A most important factor is the position of the switches controlling the head and auxiliary lights. These must be readily available to the hand used for changing gear, horn blowing, etc., and not the steering hand.

With regard to street lighting, a national standard is most desirable, for the reason that traffic on the roads at night is bound to increase. Reasonable requirements in regard to street lighting would be :—

(A) Even illumination of the road surface, of the footways and of road junctions and crossings ;

(B) No glare or dazzle from "naked" lights ;

(C) No shadows. Nothing is more disconcerting than suddenly to discover a still dark object on the road just in front, and as things are at present the only real protection the motorist can have is a sufficiently powerful headlight to overcome shadows cast by the moon and other minor lights ;

(D) A uniform height of suspension of the light together with a uniform distance between the light. This is very necessary on undulating and winding roads. Staggered lights frequently are a great danger as also is the change of lighting at the numerous boundaries of different lighting authorities ;

(E) Illumination of danger, direction, village signs and street name plates ;

(F) Some system of controlling the lights to give additional illumination when that provided by theatres, cinemas, hotels, shops, railways, etc., is curtailed, and finally ;

(G) Auxiliary lights on the lamp standards themselves to obviate accidental impact.

Possibly the ideal system of street

lighting would be from lamps fitted with parabolic reflectors projecting a strong beam in the direction of proceeding traffic, but fixed at such a height and angle as to avoid dazzling drivers on the other side of the highway proceeding in the opposite direction.

It is generally agreed that a red light is a "stop signal," and that a green light means "all clear," but motorists or any other road user do not stop on sight of a red light, for the red light ahead may be the tail light of another vehicle travelling ahead, or it may indicate an obstruction caused by road repairs, in addition it might indicate a level railway crossing.

Motorists have subconsciously developed the habit of overtaking red lights by going to the off side, and keeping to the near side when white lights appear, and it is suggested that this simple principle be adopted in lighting all highway obstructions. On this basis a green light might be standardised for central obstructions, such as those outside Buckingham Palace. A clear indication that the motorist should pass on the near side is very necessary.

DISCUSSION.

Mr. W. T. DUNN remarked that municipal authorities would be quite willing to provide better public lighting if the ratepayers would allow them to do so. Improved public lighting, therefore, depended mainly on the education of the ratepayer. In regard to shadows cast by lamps one recognised that the framework of gas and electric lamps tended to cast a shadow on the road; he believed there was in existence a lamp composed entirely of glass which would cast no shadow. In dealing with future problems in street lighting the co-operation of transport authorities should be sought. Sir Henry Maybury would naturally be specially interested in the subject and his aid should be solicited by any Committee formed to study the questions raised in Mr. Fryer's paper.

Mr. E. D. ALLEN said that motor users generally would welcome advances in street lighting. At the present time they were compelled to use more powerful headlights than they considered were quite fair to the public; with better public lighting this necessity would disappear. In spite of all that had been done, there seemed to be a good deal of scope in the direction of improving the headlights of motor vehicles. Some motorists were inclined to combine fairly powerful headlights with totally inefficient sidelights. Consequently if they applied a dimming device with the object of reducing the brightness of the headlight, the sidelights became distinctly unsafe. This was one reason why drivers were inclined to keep the headlights full on, and it would be to the interest of all concerned if the sidelights were somewhat more powerful.

One of the most interesting points in the paper was the suggestion with regard to lofty projectors for street lighting. This seemed to be a line of experiment in which the Society might do good service, which would be much appreciated by motorists.

Mr. F. POTTERTON expressed general agreement with the ideas expressed in the paper. He also pointed out that the use of low lamps on winding roads led to great difficulties, because one did not always know on which side of the road one was travelling.

Mr. W. R. RAWLINGS quoted a notice issued by a local authority to the following effect: "All vehicles must have lights when it is dark. N.B.—When the street lamps are alight it is dark." He thought that this notice would not be inappropriate when applied to some forms of street lighting. Mr. Rawlings recalled that during the war the authorities would not allow naked lights to be visible from above, and required that all lamps should be screened and that all light should be directed downwards on the pavement. Thus requirements in war time had coincided with a sound principle in street lighting, and to many people the conditions had been a welcome change. One could walk along the streets with perfect safety and see all that one desired. That was more than one could sometimes do under present

conditions, owing to the glare from exposed lights. He would be interested to know whether motorists were agreed that there was any manifest advantage in dimming headlights. He had found in his own case that there was more risk involved in the "dimming" process than in keeping the headlights full on.

Mr. MURRAY GRIFFITH inquired whether the author, when recommending the mounting of public lamps at a considerable height, had considered what happened on very foggy days. In such circumstances it was almost impossible for omnibuses to keep to the kerb. He had sometimes wondered whether some arrangement for bringing the lamps to a lower level could not be adopted on foggy nights, instead of sending out men with flares. An alternative would be to provide omnibuses with an adjustable light which, on a foggy night, could be mounted on the near side, thus enabling buses to find their way home by its aid.

Mr. WILSON questioned whether complete freedom from shadows was desirable. In such circumstances objects would tend to lose the degree of contrast by which they were usually detected and would no longer stand out "in relief."

Mr. PICKERING (Epsom U.D.C.) said there was no reason why the Ministry of Transport should not take the lead by recommending some form of signal for lighting obstructions, etc., which could be standardised throughout the country. About 75 per cent. of the roads in this country were in the hands of local authorities and in almost every case the lighting had been delegated to the parish councils; hence every village was a law unto itself in this respect.

Mr. J. S. DOW said that most of the principles advocated by Mr. Fryer, *e.g.*, in regard to absence of glare, uniformity of illumination, etc., would be fully endorsed by members of the Illuminating Engineering Society. "Shadowless" illumination, whether desirable or not, was in practice almost impossible to attain. But the diffusion of light easily secured in interior lighting would also be beneficial outside. One of the greatest defects in street lighting was that, owing to the great distance between sources of light and the absence of reflection from surroundings, objects were illuminated only by light coming from a few directions, and were therefore not fully revealed. For this reason, besides its utility in diminishing glare, the use of diffusing glassware was to be recommended.

In view of the accepted insufficiency of light in most streets, it was natural to emphasise the desirability of concentrating most of the light on the roadway. Yet the matter could not be considered only from the standpoint of motor traffic. In many cases the general appearance of the street, when artificially lighted, had to be considered. Undue concentration of light might cause inconvenient shadows from moving vehicles, and whilst possibly acceptable to a single motorist, might not answer in a crowded street. It was evident, therefore, that the choice of the best system of lighting was a somewhat complex matter.

The CHAIRMAN (Capt. W. J. Liberty) thought that everyone would agree that the time was ripe for some general agreement on principles in street lighting, not only in cities and towns, but on interconnecting roads throughout the country. The whole matter was being very carefully considered by the Illuminating Engineering Society.

Miss A. WIGGINS mentioned that at the request of the National Illumination Committee of Great Britain a Sectional Committee on Illumination had been formed by the British Engineering Standards Association. That Committee had set up a sub-committee to deal with street lighting, more especially from the standpoint of motor traffic. Every endeavour would be made to ensure the views of all interested in this subject being considered.

Mr. Fryer having briefly replied to some of the points raised, the Chair was taken by Mr. L. Gaster, and the papers dealing with the Lighting of the British Empire Exhibition were presented. In the unavoidable absence of Mr. Haydn T. Harrison, his paper was read by Mr. C. H. Cunliffe.

SOME NOTES ON THE ELECTRIC LIGHTING AT THE BRITISH EMPIRE EXHIBITION.

By HAYDN T. HARRISON.

(Abstract of a paper presented at the Conference on Illuminating Engineering, held at the British Empire Exhibition on Tuesday, August 12th, 2.30—5.30 p.m.)

IT was originally intended to deal with the outside illumination of all the buildings (excluding the Amusements Park) as one complete scheme on novel lines, but it was unfortunately found impossible to carry out this scheme in its entirety. The original scheme of floodlighting consisted of illuminating all the facias of buildings from the roofs of adjacent buildings, thus ensuring that architectural features would not be distorted by defects arising from illumination from ground level or sources at low altitude. The absence of such floodlighting in certain sections has made it necessary to add supplementary festoon lighting, not intended originally.

It was originally decided to fix large batteries of floodlights behind the copings of the roof of the Main Exhibition Buildings, the Government and large Colonial Buildings, etc., where they would not be visible to the public on the ground. These floodlights would not illuminate the lower part of the buildings and this illumination to be furnished by the ground standards.

The surfaces of the most beautiful buildings were of concrete, with reflecting values as low as 25 per cent., and from 2·5 foot-candles were found necessary to produce a good effect with white light; in the case of plastered or painted buildings less than half this value would suffice. In the original scheme simultaneous colour changes throughout the Exhibition were provided for, red and green being provided by separate networks controlled through one central dimming station capable of dealing with 600 k.w. Thus the white light could be gradually melted into the colours, and colour-combinations obtained.

Owing to the long distances between buildings, highly concentrating projectors were necessary. The problem was solved by the use of low voltage gasfilled tungsten lamps with concentrated filaments and deep short focus parabolic reflectors, directing 76 per cent. of the total luminous flux within an angle of less than 5°—probably the highest degree of concentration yet obtained with an incandescent filament as the light-source. With a 100-watt 12-volt lamp these projectors produced 300,000 c.p. at the centre of the beam, 200,000 c.p. at 1° and 100,000 c.p. at 2° on either side, the "overflow" being exceedingly small. In order to obtain these results at minimum cost silvered metal reflectors in airtight housing were used, arrangements being made for resilvering when necessary. Heat from the lamp is dissipated by surface-radiation from the housing and in practice the efficiency is well maintained. Several thousands of these projectors, illuminating facias at 300 to 1,000 ft. distance, are in use, but the complete scheme has not yet been carried into effect.

The main feature of the lighting of the grounds is the use of sources of low intrinsic brilliancy and high power, with a view to eliminating all unpleasantness due to glare. The beautiful spherical globes designed by the architects were erected at a low altitude for artistic reasons, but as the luminous area exceeds 900 sq. in. the brilliancy is low, despite the fact that these lanterns furnish 600 to 1,000 c.p. Flashed opal glass ensured uniform brightness.

The interior lighting includes the illumination of some of the largest buildings in the world. The light sources containing gasfilled lamps are suspended as high as possible. Lamps are in general equipped with concentrating reflectors of the vitreous enamelled steel type; the resultant floor-illumination of 3 foot-candles is obtained with less than 0·3 watts per sq. ft. of floor surface.

The illumination of exhibits and stalls was left to the personal requirements and taste of exhibitors, subject to certain regulations devised to ensure comfort of the public.

SOME NOTES ON THE GAS LIGHTING AT THE BRITISH EMPIRE EXHIBITION.

By G. L. JENNINGS (Brentford Gas Company).

(Abstract of paper read at the Conference on Illuminating Engineering held at the British Empire Exhibition on Tuesday, August 12th, 1924, 2.30—5.30 p.m.)

THE lighting of areas to be used for purposes of amusement interests both the showman and the illuminating engineer. It is, however, the total amount of light rather than the particular power of the units employed that is important. When the question of the lighting at Wembley first arose it was recalled that practically the whole of the Amusement area of the White City was lighted by gas. In that case high pressure lighting was used. But in the author's opinion there is now no need to employ high pressure for really effective gas lighting, and the cost of laying special high pressure mains can thus be avoided. It was resolved, at the British Empire Exhibition, to use low pressure lamps, 14½ ft. from ground to reflector, and two lamps per standard. It was further decided that lamps should be 60 feet apart and the distance across the road between the columns 30 ft. The lamps were of a new pattern, and of very strong construction, consisting of a strong copper exterior and cast superheater and carrying 16 mantles in each lamp. The weight of the lamp is 42½ lbs., so that everything connected with the fixing of these lamps should be solid. So far, including the bypass and lamp, the consumption works out to under 34 cub. ft. per hour per lamp, *i.e.*, slightly over 2 cub. ft. per mantle.

Special attention has been paid to securing rigidity in view of the general high elevation of the ground and probable wind-stresses. Maintenance has received special attention and results have been good, in spite of the fact that the atmosphere at Wembley is rather dusty, and lamps therefore require frequent cleaning. But, once any faulty glasses due to bad annealing, etc., had been weeded out, the glass breakage was reduced to a low figure. (There is still in use glass put up when the lamps were first lighted at the White City in 1908, which speaks well for the resistance of breakage of glass that has become thoroughly acclimatised to its work.)

The nominal candlepower of the lamps containing 16 mantles is 1,600; on tests an observed candlepower of 1,590 was obtained. As a statement that 2 or 3 foot-candles is provided is apt to be unintelligible to non-technical people it is useful to mention a particular instance, and it may therefore be said that the standard of lighting in this case is substantially that outside the residence of Her Majesty Queen Alexandra at Marlborough House and that on the Drive to these premises. I have found that at 10 o'clock at night, with no moon, I can walk and read my newspaper comfortably throughout the whole area lighted by gas, and that there is practically no place in the road where it is not possible to sit and read the ordinary print of a book.

It may be mentioned that the Exhibition authorities adopted the same system of lighting in the roads in the Exhibition area which are adjoining the Amusement Park, and that about 100 lamps have been put up here. The fact that, after the lighting up period has arrived, over 96 per cent. of the total people in the Exhibition are in the Amusement area is a very good tribute to the efficiency of the good lighting for attraction purposes. There are situated at various places in the grounds, where it is desirable that an extra pull should be given or where the light can be seen from a distance, a number of columns carrying four lamps, a total of 64 mantles, with an observed candlepower of over 6,300. The columns of these were made taller, the actual casting is 14 ft. 6 in. and the lamps have been fixed at a height of 17 ft. to the reflectors.

There is one other feature of the lighting to which I attach considerable importance. The hoardings and sides of

the buildings must be lighted, and as these are of greater height than the source of light, it was necessary to see that the whole of the light was not thrown in a downward direction. Accordingly burners and mantles were brought somewhat lower down than usual. One small difficulty has been the desirability of getting articles for sale near to the gas lamps: there is scarcely a lamp in the area that has not its attendant automatic cigarette-seller, sweet machine, etc., close to it. This makes access to the lamp slightly more awkward than it need be, but it has not been a matter of great difficulty.

The lamps are lighted as soon as dusk arrives. No fixed time is made. They are extinguished shortly after 11 o'clock, a few being allowed to remain lighted where work is in progress during the night.

DISCUSSION.

The CHAIRMAN (Mr. L. Gaster), in opening the discussion, explained that the Illuminating Engineering Society was not in any way responsible for the lighting of the Exhibition. Mr. Harrison's paper had explained the circumstances under which the electric lighting was carried out. Whilst there were some respects in which the lighting was in advance of that at most previous exhibitions, it was unfortunate that the authorities had not seen their way to approve the complete carrying out of the original scheme. It had apparently not been sufficiently realised that a national exhibition of such importance demanded lighting of a special character, and that the method of illumination *per se* should be regarded as an exhibit which, rightly handled, would prove a great attraction to visitors.

Mr. F. C. TILLEY, in opening the discussion, said that those responsible both for the gas and electric lighting deserved credit for their efforts in admittedly difficult conditions. Mr. Jennings was to be congratulated on his admirable work in the Amusement Park. He hoped, however, that his paper would not create the impression that there was now no scope for high pressure gas lighting. Excellent as the results with low pressure were, high pressure lighting had still a field of its own.

Mr. C. E. RAPHAEL remarked that from the utilitarian standpoint the gas lighting of the Amusement Park seemed very efficient. In regard to the electric lighting it seemed to him that the flood lighting could have been developed on a greater scale and would then have been extremely interesting and instructive to those concerned with such work. No doubt this would have been the case if the original designs had been adhered to. As it was the impression received was that the intensity was inadequate, and that the use of light should have been on a much greater scale. As regards the interior lighting he thought that, whilst grave defects were avoided, the general effect was somewhat monotonous.

Mr. GEO. HERBERT agreed that the lighting of the Amusement Park was quite exceptionally bright. As regards the other section of the Exhibition he thought that different methods would naturally be expected. It was at least satisfactory that the old conventional methods of lighting exhibitions by means of festoons of bare lamps had been dropped, and he thought it might be said that the British Empire Exhibition was better lighted than other exhibitions held in the past in this country. The interior lighting was on a more uniform plan than usual, the freedom from glare being an improvement. The exterior lighting might be considered too weak, but Mr. Harrison had explained that this was due to the original plans not being accepted.

Mr. J. S. Dow agreed with Mr. Herbert that on the whole the lighting marked an advance on previous methods. Yet it was evident that finer results might have been achieved if the design of the buildings and the methods of lighting had been considered together at an earlier stage, and the plans deliberately agreed upon carried out in their entirety.

Mr. Cunliffe having briefly replied to some of the points raised in the discussion, a vote of thanks to the lecturers and the Chairmen terminated the proceedings.

INSTITUTION OF PUBLIC LIGHTING ENGINEERS AND SUPERINTENDENTS.

First Annual Meeting.

The First Annual Meeting of the Institution of Public Lighting Engineers and Superintendents was held in Glasgow during September 16th–18th. After the members had been officially welcomed to the City of Glasgow the election of officers for the current session took place, Mr. S. B. Langlands being re-elected President and Capt. W. J. Liberty Hon. Secretary. The Hon. Treasurer is now Mr. E. M. Severn of the South Metropolitan Gas Co.

Presidential Address.

The address of the President (Mr. S. B. Langlands) was devoted mainly to an account of the development of public lighting in the city of Glasgow, of which he is Chief Lighting Superintendent and Inspector. In Glasgow there are over 500 miles of streets to be lighted. The electric illuminants comprise 1,066 flame arc lamps, 1,005 gasfilled lamps and 1,543 vacuum lamps; there are also over 25,000 gas lamps of various kinds apart from the additional lamps required for closes and stairs. Both Illuminants are therefore well represented. In the busiest thoroughfares they aimed at a maximum of 5 foot-candles and a minimum of 0·1 foot-candle—the mean value being somewhere about 2 foot-candles.

In the later part of the address Mr. Langlands described the organisation of the Glasgow Public Lighting Department, by which about 1,200 persons are employed. Generally speaking, enough stocks of lamps and lighting appliances were carried to last for 3 months and there was a well equipped workshop in which street lanterns could be made and repairs executed. A feature was the series of laboratories and drawing offices in which much experimental work was done; some years ago researches on burners had led to a saving of about £30,000 in gas consumption. In the drawing offices they had maps of the whole city which were kept thoroughly up to date.

Electric Lighting Mains in Glasgow.

The first paper, by Mr. R. B. Mitchell, of the Glasgow Corporation Lighting Department, traced the development of public lighting from its earliest stages. An account was given of various problems arising in connection with the choice of cables, and it was stated that wherever possible overhead mains were now being used. Since 1919 new installations have been equipped with 250 v. lamps. Time switches are largely used for the control of public lamps, a feature being the special "Glasgow arc starter" for turning on street lamps at regular intervals in groups, so as to avoid a sudden increase in the load.

The Projection of Light.

Mr. Haydn T. Harrison, in his paper on "The Projection of Light" pointed out that, for the safety of driving, a minimum illumination of 0·1 foot-candle was necessary, but in public streets today not infrequently only 1/10 of this figure was provided. Hence the motorist was driven to rely on a powerful headlight. From this standpoint there was not much object in illuminating surfaces, say 10 feet above the roadway. If it were assumed that all that is necessary is to illuminate an area, say 40 feet wide by 10 feet high, the provision of the necessary illumination would become much easier. To produce 0·1 feet-candle at a distance of 200 feet 4,000 candle-power over an angle of 12° would be needed. This degree of concentration is easily achieved with existing flood-lighting projectors.

In the case of roads where safety of traffic is the main consideration and where the necessary illumination could not be economically provided by ordinary methods, Mr. Harrison suggested the use of highly concentrating projectors at intervals of, say, 1,000 feet, or five to the mile, each taking about 100 watts per projector. If such lights were mounted at the ordinary height of street-lamps they would, of course, give rise to considerable glare. In order to avoid this

the projectors should be brought down below the level of the eye.

In conclusion Mr. Harrison remarked that these suggestions were not to be taken as applying to the lighting of streets in cities or large towns, but rather to country roads or thoroughfares in outlying districts.

Mr. A. B. Spears, of Glasgow, representing the Automobile Association, pointed out that the motorist needed lighting conditions very much better than those considered adequate in the days of relatively slow traffic. It was recognised that the conditions provided in various towns throughout the country differed widely. What was needed was a uniform standard, all roads being lighted according to their recognised requirements.

Street Lighting and Visibility.

In the next paper, by Mr. E. J. Stewart on "Street Lighting and Visibility," the subject was treated from a somewhat different aspect. Visibility, it was remarked, is not directly proportional to illumination. The provision of a certain candlepower or illumination in foot-candles might be necessary to satisfy a public lighting authority of the performance of a contract. But the question remained whether the result would be described by the public as "good lighting." It was in giving the public what it wanted, yet at the same time leading hitherto loose and confusingly various individual preferences to become wants of the right kind, that public lighting authorities and their engineers had so useful a field. Of their work the eye of the ordinary user of the street is the ultimate judge. If he thinks a street "dull" it is difficult to convince him that he is wrong. Similarly the motorist may have views of his own. All this shows that street lighting is partly a psychological problem. While standardisation, for the sake of efficiency and economy, is one of the prime needs of street-lighting, many individual problems have to be recognised and guarded against.

Mr. Stewart illustrated his paper by references to various methods of specifying street lighting, attempted tests of conditions of visibility, etc. He also summarised the chief requirements in street lighting as follows:—

(1) The revealing of stationary and moving obstacles, particularly pedestrians, to other traffic, especially drivers of fast motors.

(2) The revealing of the route to drivers and pedestrians varying in degree from a general outlining of the way with illumination sufficient to show sudden bends, cross-roads and obstacles in the roadway, to a more exact vision of all objects from side to side of the street in a continuous illumination.

(3) The revealing of names of streets, numbers of houses, etc., traffic warnings and other signs.

(4) Legibility—at all places or at some—of (say) a time-table or an address on a letter.

(5) The recognition of passers by.

(6) The provision of a cheerful and pleasing appearance at night.

(7) The attraction of traffic to the street by the degree or quality of its lighting.

(8) The suitable illumination of architectural features.

Mr. Harrison, who opened the discussion on this paper and his own, congratulated Mr. Stewart on presenting a record of much useful experience. He fully agreed that it was necessary to take into account the psychological aspect, as a supplement to photometric readings, but the latter were valuable for purposes of record. It was necessary to know, not only that a lighting committee was satisfied with the public lighting, but *why* they were satisfied.

Mr. C. H. Sully (Director of the Electric Lamp Manufacturers' Association of Great Britain, Ltd.), laid stress on the importance of visibility of objects in the streets. The solution of the lighting problem was in general best secured by the use of high power lighting units mounted 20 to 25 feet above the ground, so that they did not come within the direct range of vision. It was important that all these matters should be studied by electrical engineers who

were apt to take things too easily. He considered, however, that there was room for both gas and electricity. There was much virgin soil to be cultivated and in this work both gas and electrical engineers could be of assistance.

In the course of further discussion Mr. W. Millner pointed out the special problems arising in connection with the lighting of new main roads connecting towns and cities and likely to carry a considerable volume of motor traffic. All these roads, which would cross the boundaries of many different authorities, must be adequately lighted; and an effort must be made to secure uniformity. Mr. Harrison also emphasised the importance of the motorist's standpoint. Motorists were already using powerful lights at a height of about 3 feet above the roadway. Hence local authorities might well consider the advisability of placing permanent properly screened lighting units below the eye-level. It was an interesting experience to look down a road so lighted; the whole of the roadway was flooded with light and objects on it were clearly visible.

Mr. H. H. Gracie, of Edinburgh, referred to the importance of lighting superintendents preparing specifications when inviting tenders from gas or electrical undertakings, and Mr. Stewart, in replying to the discussion concurred. He also endorsed the remarks of several speakers in regard to the importance of regular and systematic maintenance.

A useful item in the proceedings was a tour with the object of enabling members to inspect the lighting of Glasgow and at a later stage a visit to Edinburgh was also made, when the public lighting of this city was also examined. In both cases the delegates were entertained to a civic luncheon.

A DEMONSTRATION OF STREET LIGHTING.

THE September issue of the *Transactions of the American Illuminating Engineering Society* contains an account by Mr. F. C. Caldwell of a demonstration of street lighting systems in Columbus, Ohio. A committee had been formed to consider methods of improving the existing public lighting, and one of its first decisions was that actual inspection of the conditions available with different methods should precede their report. The invitation to put up specimen installations was accepted by several manufacturing firms and three classes of lighting were agreed upon :—

In residence streets, 1¼ watts per foot of street;

In boulevards, 2½ watts per foot of street;

In business streets, 6-8 watts per foot of street.

A series of different systems complying with these classifications were studied. They included luminous arc lamps, incandescent lamps in various fittings (two on a standard), 750-watt lamps in refractor globes, etc. The committee is at present making a study of the various exhibits, the posts and lamps being erected in typical streets. The chief problem at present is to decide what weight to give to the various requirements of good illumination, *i.e.*, sufficient light on the roadway, absence of glare, etc. Attention is also being devoted to the influence of the amount of light allowed to fall on the faces of buildings, upon the general appearance of streets, the lighting of cross roads, and problems connected with æsthetic effect. For this latter judgment the assistance of a group of artists and architects has been sought.

THE MEASUREMENT OF CANDLE-POWER BY MEANS OF THE PHOTO-ELECTRIC CELL.*

By F. K. Moss.

The measured value of light is one of the few quantities that depends on the personal judgment of the observer for its determination, and is a quantity that has not hitherto been readily obtained with a direct reading instrument. The photo-electric cell offers a possible solution, and in this article a summary of some recent experiences with such cells is given.

Since measurement of mean spherical candle-power has practically replaced the old measurement of horizontal values, an integrating sphere was used in conjunction with the photo-electric cell for all measurements. The cell is mounted approximately at the centre of a 60-inch sphere, in such a manner that the cell window faces the inner reflecting surface of the sphere. The entire cell is shielded from direct radiation from the test or standard lamp by means of an opaque screen. This position was assigned to the cell as the most convenient. Theoretically, the most desirable position would be at the aperture of the sphere, as the cell would not then be subjected to heating due to the proximity of the lamp studied.

The cell used was of the potassium hydride type which is considered best for work of this nature. Small storage batteries were used to supply voltage to the cell, from 2 to 200 v. being available. All connections were carefully insulated with cambric tubing; very variable results are obtained if the insulation is at all faulty. The galvanometer was of the Leeds and Northrup type fitted with a concave mirror and special damping device. The cell is connected in series with the galvanometer, battery and switch through a resistance of 50,000 ohms.

When light falls on the window of the cell, its resistance is diminished and a current flows through the galvanometer, resulting in a deflection on the scale, 18 feet away. In selecting a cell, consideration is paid to the following points: (A) Sensitivity to radiant energy; (B) Response to incident radiation; (C) Selectivity to certain wave-lengths, as compared with the eye; (D) Duplication of readings; and (E) Life of cell, effect of temperature, dark, currents, etc.

The potassium cell is one of the most sensitive of the numerous types of cells designed. Unlike the selenium cell, it is for all practical purposes instantaneous in operation, which is a most important characteristic in its favour. The response obtained for a given illumination of the cell window is a function of the impressed voltage. A wide variation in current can be obtained by varying the voltage, but the limit is reached at about 200 to 250 volts. If the voltage is increased beyond this point, the cell will commence to glow. Curves are presented in the original paper illustrating the relation between deflection and impressed voltage. From these it appears that it is desirable to operate the cell at a voltage as low as possible, since the lower the voltage the less the possible error due to any fluctuations in voltage.

From actual experiments it was found that a change of less than 0·1 per cent. in candle-power could be detected. The cell is therefore more sensitive than would actually be required for photometric measurements. By tests on a series of cells, it was found that the relation between deflection and candle-power is a straight line, *i.e.*, that the deflection may be regarded as proportional to the intensity of light for the range of candle-power considered. This is a most desirable quality in a cell used for photometric work.

*Abstract of a contribution to the *General Electric Review* (U.S.A.).

In regard to "selectivity," however, it is less satisfactory. The maximum sensivity is in the blue-violet part of the spectrum, decreasing with increasing wave-length until it is practically zero for red light. This difference from the curve of sensitiveness of the normal eye needs to be borne in mind. It would naturally introduce complexities if an attempt to compare sources of light differing widely in colour were made. But in comparing sources of the same type, or in purely comparative work with the same source, it is not important. It has been found that the correctness of readings is not materially impaired if a glow lamp is subjected to variations in filament-temperature of a few per cent. up or down. In cases where the colour of the light from a glow lamp is materially different from that of a standard, it is possible to make a correction. Such differences may also be diminished by using colour screens to diminish the accentuation of the blue-violet. But as the sensitivity of the potassium hydride cell does not extend completely across the spectrum, it is not possible to bring about complete resemblance to the sensitivity-curve of the eye by this means.

In the case of ordinary measurements, therefore, standard lamps should fulfil the following conditions :—

(1) The type of the standard should be essentially the same as that of the lamp to be tested.

(2) All standards must be of the same rating in watts per spherical candle-power.

(3) The lamps must differ in candle-power so that a curve can be drawn over the range of candle-power that it is desired to read.

The reading obtained with a cell depends upon its temperature. The absolute value of the temperature is of little consequence provided it remains constant during the operations. But where a gradual change in temperature is regarded as possible, the error is best eliminated by taking observations on a group of lamps, and repeating the tests in the reverse order, in each case taking the mean of the two values. When the cell is in complete darkness no appreciable current should flow through it.

It is estimated that the time consumed for photometric tests done by the aid of the cell is approximately one-tenth of that required for work of similar accuracy done in the ordinary way, *i.e.*, with two or three observers and perhaps ten readings per lamp per observer. But at present no proper estimate of the relative time taken in a lamp factory where speed is usually more important than exact great precision, can be made.

Individual readings on the same lamps rarely differ by as much as one-half per cent., and the record of tests made at different times suggests an average error of determination well within this range.

THE CONTROL OF LAMPS IN PORTABLE PHOTOMETERS.

It is now agreed that an efficient illumination-photometer must embody some instrument for controlling the lamp, either an ammeter or a voltmeter, and a suitable adjustable resistance. The ammeter has one evident advantage —it ensures that the same current will always pass through the lamp. But the change in candle-power resulting from an incorrect reading is about twice as great as if a voltmeter were used. The voltmeter is from this standpoint the better instrument, but it should be connected directly across the lamp and any possibility of loose contacts must be carefully guarded against.

In any case the use of a controlling instrument and adjustable resistance enables the lamp to be in a fixed position. If the candle-power of the lamp falls the instrument can be made to read correctly by merely increasing the current through the lamp slightly. One need not provide any means of altering the distance of the lamp from the photometer-screen, or other compensating mechanical device, such as was sometimes embodied in instruments in the past.

A NEW PHOTOMETER BASED ON ACUTENESS OF VISION.

GREAT as has been the service rendered by illumination photometers of the ordinary variety, utilising a small comparison lamp fed by a battery, it is often felt that something simpler would be useful. To those unfamiliar with technicalities, the necessity for keeping the battery charged is a nuisance, and to some people the actual photometric comparison presents difficulties.

The possibility of simple and approximate instruments based on " acuteness of vision " has often been suggested, and in *Licht und Lampe* an apparatus of this kind (System Dr. H. Lux) is described. This instrument, the " Raster-photometer," is based on the phenomenon which occurs when two glass discs, each bearing a number of fine opaque primary lines, are rotated with respect to one another. This effect appears to have been described by Dr. H. E. Ives in 1910 (*El. World*, 55, p. 939). As one of the discs is rotated, the breadth and distance apart of the " secondary lines " seen by the eye changes, and a point is ultimately reached when these lines become so thin and close together that they cannot be distinguished. This point is determined mainly by the nature of the primary lines engraved on the discs and the angle of rotation ; but it is also affected by the brightness of the surface against which they are viewed. With a strong illumination finer lines can be perceived than when the illumination is weak. This, therefore, forms the basis of the photometer.

The two discs are mounted at one extremity of a tube, and the observer looks at them through an eyepiece, using as a background a standard white surface. The instrument is calibrated in the laboratory by observing the angle corresponding to disappearance of the lines with various intensities of illumination on the standard test surface. It would appear that the calibration would be, to some extent, a function of the acuteness of vision of the observer, as in all instruments of this class. It is stated, however, that for fairly normal eyes, or for eyes suitably corrected with glasses, the personal variation is not great over a range of brightness from 10 millilamberts to 1 lambert. The best results are obtained with about 50 to 100 primary lines per cm. The instrument will answer for tests of illumination up to 100 lux (very roughly 10 foot-candles), and the range can be extended to 400 lux by introducing a neutral or dark glass in the field of vision—which necessitates a separate calibration.

In making measurements of illumination, the standard white surface is placed at the point where the illumination is to be determined, and used as the background to the lines. But the instrument can also be applied to rough determinations of the reflecting power of surfaces, if the absolute reflecting power of the standard white surface is known, or for determinations of brightness.

It is naturally understood that the order of accuracy attainable with an instrument of this kind is not comparable with that possible with illumination photometers of the standard type. But it is hoped that it will prove useful for measurements in factories and elsewhere in cases where simplicity and convenience are more important than great accuracy.

THE ILLUMINATING ENGINEERING SOCIETY (U.S.A.).

Eighteenth Annual Convention.

THE list of papers for the Eighteenth Annual Convention of the American Illuminating Engineering Society, this year held during October 27th to 30th, contains many interesting items. There are the usual reports of committees, on progress, motor vehicle lighting, nomenclature and standards, research and lighting legislation. Several papers deal with various aspects of daylight illumination, including the use of recording apparatus and the selenium cell. An afternoon session is devoted to a review of recent progress in the effect of light on plant growth, and we notice that on this occasion the influence of *colour* is to be discussed. Another group of contributions deals with industrial lighting, show-window lighting and decorative and theatrical lighting. Finally, there was an afternoon devoted to effects of light on the eye, and its relation to glare, visibility and speed of vision.

The rapid development of illuminating engineering is illustrated by the manner in which the subject is being divided into groups, each offering many interesting problems for solution.

The President for the current year is Mr. E. C. Crittenden, of the Bureau of Standards, whose name is associated with many useful researches in photometry, and who is the Chairman of the Committee on Nomenclature and Standards.

OBITUARY.

William Maddock Bayliss

Born 1860. Died 1924.

WE record with great regret the death of Professor Sir William Bayliss, which occurred on Wednesday, August 27th. Sir William was regarded as one of the most original and brilliant of British physiologists, and the knighthood conferred on him in 1922 was a fitting recognition of his versatile work, already honoured by Fellowship in the Royal Society. He was the author of many papers on physiological subjects. A feature of much of his work was the evidence they afforded of a mastery of cognate fields of knowledge, bringing advances in chemical and physical science into line with the latest developments in physiology. It was doubtless this wide outlook that led him to interest himself in the effects of light on the human body, on which subject he became a recognised expert. He was the Chairman of the Committee appointed by the Medical Research Council in 1922 to advise on methods of obtaining better knowledge of the effect of sunlight and other forms of light upon the body in health and disease. It is a misfortune that his services should be lost in connection with this field of work, which has attracted so much attention during recent years.

For many years Sir William Bayliss was a member of the Council of the Illuminating Engineering Society, and of which he was elected a vice-president in the present year. In 1918 he read an instructive paper before the Society on "Light and Vision"; and he was an active member of the Joint Committee on Eyestrain in Cinema Theatres, which reported in 1920.

Notwithstanding his great scientific attainments, Sir William was one of the most unassuming of men, always ready to share his knowledge with others, and with a geniality which won the affection of all who came in contact with him.

TOPICAL AND INDUSTRIAL SECTION.

[At the request of many of our readers we have extended the space devoted to this Section, and are open to receive for publication particulars of interesting installations, new developments in lamps, fixtures, and all kinds of apparatus connected with illumination.

The contents of these pages, in which is included information supplied by the makers, will, it is hoped, serve as a guide to recent commercial developments, and we welcome the receipt of all *bona-fide* information relating thereto.]

"CORRECT ARTIFICIAL LIGHTING."

A RECENT catalogue issued by Benjamin Electric, Ltd., under the above title (List No. 700) is a distinctly enterprising and well got-up production. The introductory section entitled "Good Illumination—an Industrial Necessity" emphasises the economic importance of good lighting in promoting efficiency and diminishing accidents—one case in which better lighting led to a 25 per cent. increase in production being quoted. Attention is drawn to the necessity of eliminating glare. The argument that the contraction of the pupil, due to exposure of the eye to bright light, prevents its seeing objects of moderate brilliancy is doubtless sound; we think, however, the illustration showing the state of the pupil in the two cases needs a little modification. It would carry the point better if the lids of the eye with the contracted pupil were shown nearly closed—as would presumably be the case in practice.

Requirements of correct lighting and methods of planning lighting installations are next considered and the Benjamin Lightometer is illustrated. There is also a table of illumination intensities for various processes; a manager adopting these could certainly feel that his lighting was well above the minima at present often met with in factories.

The body of the catalogue is devoted to illustrations and particulars of all sorts of lighting fittings. We would like to single out the "Biflector" fittings as a recent type, probably not familiar to all our readers. These units, with their special opal glass canopy and screen, are considered specially suitable in cases where a comparatively low mounting height, coupled with wide distribution of light, is needed. In such circumstances the elimination of glare is not always easy, but the screen provided in this case is believed to overcome this difficulty. Throughout the book there are many attractive illustrations of lighting installations in factories, showrooms, shops, etc., including a pleasing view of the panoramic scenery illumination in the Nigeria Pavilion at the British Empire Exhibition.

A NEW USE FOR COLOUR-SPRAYED LAMPS.

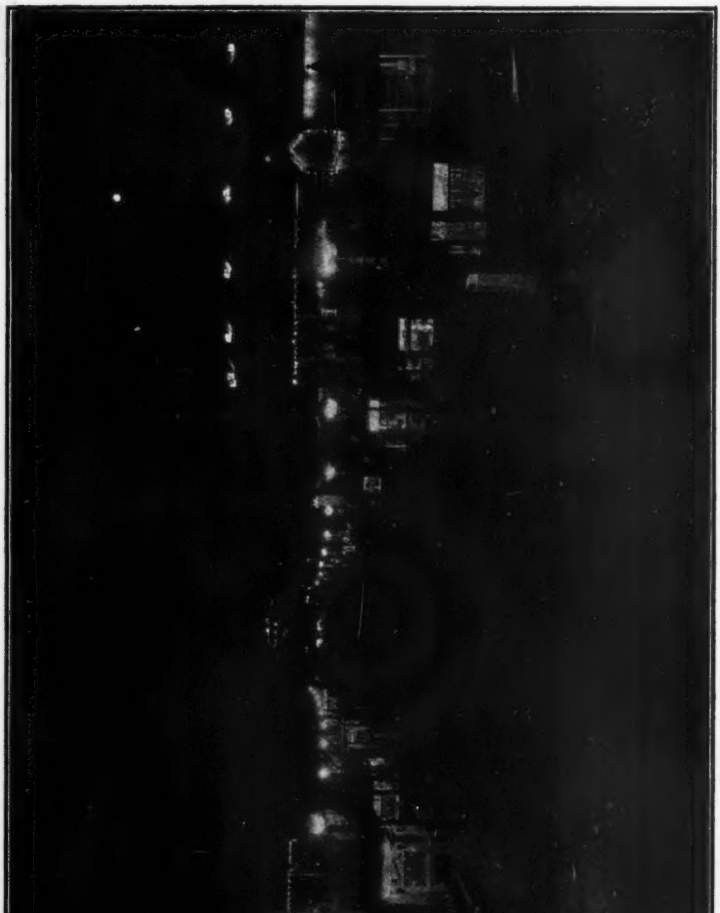
THE general application of colour-sprayed lamps has been so successful that it is not surprising for one to learn occasionally of special services for which these lamps are employed.

An occasion of interest has recently occurred in Kent in connection with the trunk road which passes through Maidstone. A certain amount of road widening has been done in Maidstone, but where this widening ceases it was considered desirable to erect a warning light.

The requirements of Mr. E. E. Hoadley, M.I.E.E., Engineer and Manager, Borough of Maidstone Electricity Supply, were:—"A red light which would give practically the same result as an ordinary red obstruction danger lamp."

Accordingly the end of the widening of the main arterial road, pending its completion through Maidstone, was marked in this way; an ordinary street lamp standard and fitting equipped with a 60 watt red colour-sprayed Osram lamp being used for the purpose described.

We understand that this arrangement serves as an excellent danger warning.



The above view is a photograph of one of the main avenues in the Amusement Park at the British Empire Exhibition, which is lighted throughout by gas.

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GAS LIGHTING AT THE BRITISH EMPIRE EXHIBITION.

THE illustration on p. 142 shows one of the main avenues in the Amusement Park at the British Empire Exhibition, lighted by gas. The photograph appeared in a recent issue of *A Thousand and One Uses for Gas*, which contained a short reference to the applications of gas for lighting, heating and cooking at the Exhibition. It is stated that the demands of the 50 restaurants, the various palaces, pavilions and kiosks, entailed the laying of 13 miles of mains to deliver some 750,000 cubic feet of gas daily. It may be recalled that the lighting is effected by low pressure inverted incandescent gas lamps on columns 60 feet apart and 14 ft. 6 in. high, and that each column supports two lamps, estimated to give an aggregate of 3,200 candlepower. At certain special points where additional light was needed to attract attention, columns carrying four lamps, giving a total rated candlepower of 6,300, were installed.

THE 1924-25 WELSBACH CATALOGUE.

THE Welsbach Catalogue for the 1924-5 season is quite an imposing volume. The Mantle Section alone occupies over 30 pages, and the variety of types, for low pressure and high pressure gas and for use with spirit, petrol-air gas and incandescent paraffin lamps, is considerable. The Burner Section includes some novel types and the treatment of glassware is exceptionally complete. Special interest attaches to the "supastone" three-ply glass, to which reference has previously been made in these columns. Many types of fittings for inverted burners, indoor and outdoor lamps and street lanterns are shown. To illuminating engineers it is of interest to observe that a variety of electric lighting fittings is also illustrated and that gas and electric stoves both figure in the catalogue. There is also a final section dealing with various incandescent lamps using petrol, paraffin, etc.

OPTICAL INSTRUMENTS.

A VERY complete catalogue just issued by Adam Hilger, Ltd., contains particulars of much apparatus of interest to those doing research on illumination. In addition to such instruments as spectrometers, polarimeters, interferometers, etc., there is a section devoted to spectrophotometry. Some of the instruments described are suitable for work on ultra-violet and infra-red light, others (such as the Hilger Wavelength Spectrometer with Nutting Photometer), enable distribution of luminosity in the visible region to be studied. The value of such apparatus in connection with investigations of artificial daylight is well recognised, and increased attention is now being paid to this field of knowledge. Another instrument listed is the Nutting Colorimeter which, as its name implies, serves for the analysis and specification of colours, for instance, those of papers, powders, liquids, textile fabrics, etc. A useful feature of the catalogue is the inclusion of references to literature bearing on the use of the various appliances.

LIGHTING PUBLICITY.

THE August issue of the *Osram Bulletin*, a special publicity issue, gives expression to the campaign to "sell Better Light and More of It." A great variety of posters is illustrated, those dealing with better home lighting being a special feature. We notice in this connection a reproduction of a chart, bearing in four columns a picture of a typical living room, brief suggestions for lighting, particulars of lamps and fittings recommended, and illustrations of suitable fittings. On this basis the various rooms (hall, dining room, drawing room, bedroom, etc.) are dealt with in succession. Another ingenious item is the poem ("with apologies to the Opal Shade of Longfellow") terminating in the couplet "Sing the song of Hiawattage —Tell the tale of *Better Lighting!*"

REVIEWS AND PUBLICATIONS RECEIVED.

Tranactions of the Illuminating Engineering Society (U.S.A.). Vol. XIX, No. 7, September, 1924.

RECENT issues of the *Transactions of the Illuminating Engineering Society in the United States* have contained specially interesting matter. The September number contains a report by the President, Mr. E. C. Crittenden, on the Session of the International Illumination Commission in Geneva. The paper by Dr. John W. Lieb on "The Furtherance of Good Lighting by American Central Stations," read at this gathering, is also reproduced. The paper gives many instances of co-operation between electrical manufacturers and supply undertakings, a feature being the campaign to promote better lighting in the home. Reference is also made to the decision whereby the National Research Council has been asked to undertake a thorough investigation of the effect of improved lighting illumination upon efficiency and production, as well as upon shrinkage and spoilage in industry. This research, which is under scientific control, is expected to produce valuable results.

Another interesting item is the account by Mr. B. E. Shacklewood and Mr. D. W. Atwater, of the lighting of the Hudson River Vehicular Tunnel. This is illustrated by pictures of a number of models showing in miniature the proposed methods.

Licht und Lampe.—Recent issues of this Journal, published in Berlin, contain a summary of the proceedings of the German Illuminating Engineering Society, held in Jena on September 18th. An introductory address by Dr. L. Bloch contains a résumé of recent activities of the Society and a list of papers read, which cover a wide field. Reference is also made to the founding of the Illuminating Engineering Institute in Karlsruhe, and the formation this year of an Illuminating Engineering Society in Austria. There are a number of committees at work, dealing with such matters as Units and Nomenclature and the Lighting of Schools and Factories. Generally speaking, it appears that the subjects that are arousing attention in Germany are substantially the same as those receiving investigation in this country.